3D Project File Delivery Guidelines

This document will be periodically updated based on latest guidance as well as issues discovered. Any comments, questions or concerns regarding the content of this document should be brought to the attention of:

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General

In recent years, transportation agencies have started to plan and design transportation projects using three dimensional (3D) engineered models due to the benefits realized in both the design and the construction phases of a project.

Generating a 3D engineered model during the design phase provides many benefits including the following:

- A more comprehensive design is able to be developed.
- Enables integration of several design processes which results in quicker updates during the design phase.
- The designer is able to more accurately detect and correct design issues and conflicts during the design phase.
- Constructability issues are easier to detect during the design phase.
- 3D file development leads to more accurate quantity estimates.

Additional benefits can be realized when the 3D engineered model is provided to the contractor including the following:

- The contractor is able to identify and rectify constructability issues prior to mobilization saving time and money.
- The contractor has better control of pavement material and quantities through use of Automated Machine Guidance (AMG).
- Faster construction execution with AMG, which has associated efficiency and safety benefits.
- Provides the contractor with insight as to the engineer's design intent.
- More efficient workflows for measurement of quantities and payment.

Not all projects will benefit equally from the generation of a 3D engineered model. Creating a 3D engineered model during the design phase requires an investment of time and resources which has an associated cost that should be considered individually on each project.

3D engineered models are extremely beneficial in analyzing clash detections during the design phase. A clash occurs when different infrastructure elements occupy the same space in a proposed design. Generating a 3D engineered model is extremely beneficial in detecting these clashes during the design phase so that remedies can be evaluated and considered during the design phase resulting in reduced construction time and cost.

Generating a 3D engineered model is also beneficial on large earthwork projects where Automated Machine Guidance (AMG) may be considered during the construction phase. Projects which include the following earthwork operations will benefit from the creation of a 3D engineered model:

- Large application of sub-base material spreading,
- Mass earthmoving,
- Stormwater management facilities requiring grading, and
- Wetland mitigation areas requiring earthwork.

The generation of a 3D engineered model is also extremely beneficial for AMG purposes for concrete pavement construction.

In order to accurately generate a 3D engineered model, it is essential to have complete ground survey of the existing topography. Projects that use aerial survey or other incomplete topographic survey methods should recognize the limitations of the 3D engineered model and subsequent electronic files created from the 3D engineered model due to the accuracy level of the initial topographic survey. Projects that use incomplete topographic methods can still generate and use 3D engineered models during the design phase but the model's limitations must be understood by the designer. Consideration of which 3D project files will be provided to the contractor should occur during the scoping phase of the project so these survey considerations can be taken into account during the project's survey activities.

All electronic project files that are to be made available to the contractor, must be reviewed in accordance 3D Engineering Model Checklist available on the Design Resource Center.

Software

The Department currently uses two different versions of Bentley Software packages to create a 3D engineered model during the design phase. These two different software packages require a unique workflow and are capable of generating different digital deliverables.

Select Series 2

One version of Bentley Software that has been used to generate 3D engineered models is InRoads Select Series 2 (SS2). SS2 should only be used on existing projects that are in the design phase and should not be used on any project that is about to enter the design stage.

Deliverable Files

Consideration should be given to which electronic files will be created for the contractor's use during the scoping phase in order to determine the existing topographic information required.

Figure 1: SS2 Deliverable Electronic Files

( )	NONE
( )	ASCII DATA FILES WITH COORDINATES AND ELEVATIONS FOR PROPOSED POINTS AS SELECTED BY THE ENGINEER.
( )	EXISTING DIGITAL TERRAIN MODEL, IN .DTM FILE FORMAT, COMPATIBLE WITH SOFTWARE CURRENTLY USED BY DELDOT.
( )	PROPOSED DIGITAL TERRAIN MODEL, IN .DTM FILE FORMAT, COMPATIBLE WITH SOFTWARE CURRENTLY USED BY DELDOT.
( )	DESIGN FILE, IN .DGN FILE FORMAT, THAT CONTAINS 3D FEATURE LINES FOR THE PROPOSED DESIGN. 3D FEATURE LINES ARE FOR THE PROPOSED TOP SURFACE ELEVATION ONLY.

Figure 1 shows the deliverable electronic files that can be generated by SS2.

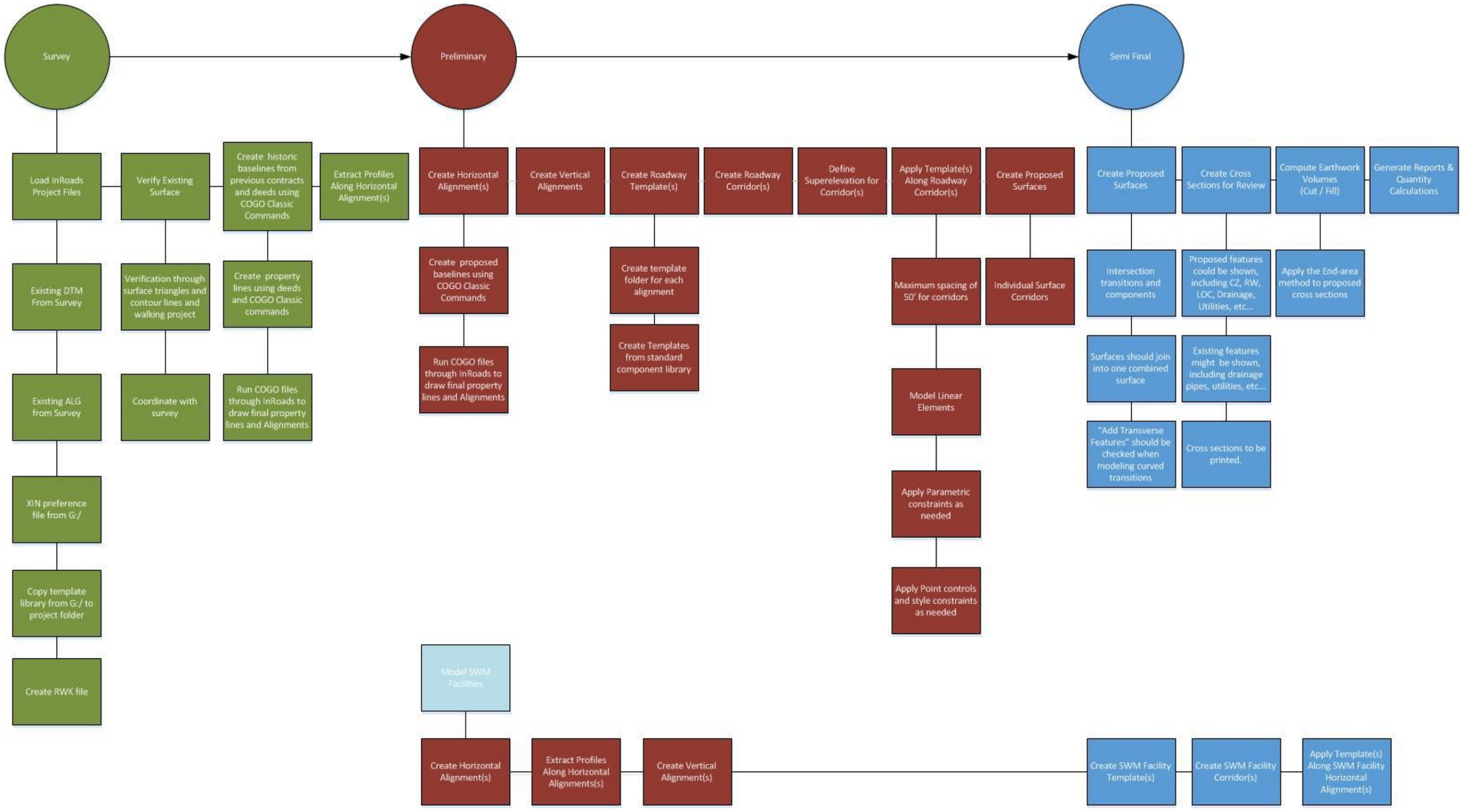
- **ASCII Data Files with Coordinates and Elevations for Proposed Points as Selected by the Engineer –** This file should be made available to the contractor on all projects. The points that are provided should be chosen by the engineer but generally include all the proposed geometric points that are shown on the plans. These points can also include associated elevations at the discretion of the engineer. This file should be provided as a text file.

- **Existing Terrain Model, in .DTM File Format, Compatible with Software Currently used by DelDOT -** Where a complete topography survey has been performed in accordance with DelDOT standards, the existing .DTM file should be provided to the contractor.
- **Proposed Digital Terrain Model, in .DTM File Format, Compatible with Software Currently used by DelDOT –** Providing the proposed digital terrain model should be considered in accordance with the guidance in the General section of this guide. When triangles are to be provided as part of the files provided to the contractor, a maximum triangle length of 5 ft should be used in all areas with the potential to use Automated Machine Grading (AMG) during construction activities.
- **Design File, in .DGN File Format, that Contains 3D Feature Lines for the Proposed Design. 3D Feature Lines are for the Proposed Top Surface Elevation Only –** Providing the proposed digital terrain model should be considered in accordance with the guidance in the General section of this guide.
- **Right of Way Plans** – Right of Way should be made available to the contractor on all projects where Right of Way Plans are generated.
- **Cross Sections –** Cross Sections with complete existing and proposed information should be generated and provided to the contractor on most projects. Cross sections do not need to be provided on small scoped rehabilitation or repair of existing infrastructure projects unless determined necessary by the engineer. See the Plan Submission Checklist for information to be included.

Workflow

Figure 2 has been created and included to document the designer's workflow when utilizing InRoads SS2 when generating a 3D engineered model.

Figure 2: Designer's Workflow in SS2



Select Series 4

One version of Bentley Software that has been used to generate 3D engineered models is InRoads Select Series 4 (SS4). SS4 should be used on all projects that are entering the design stage.

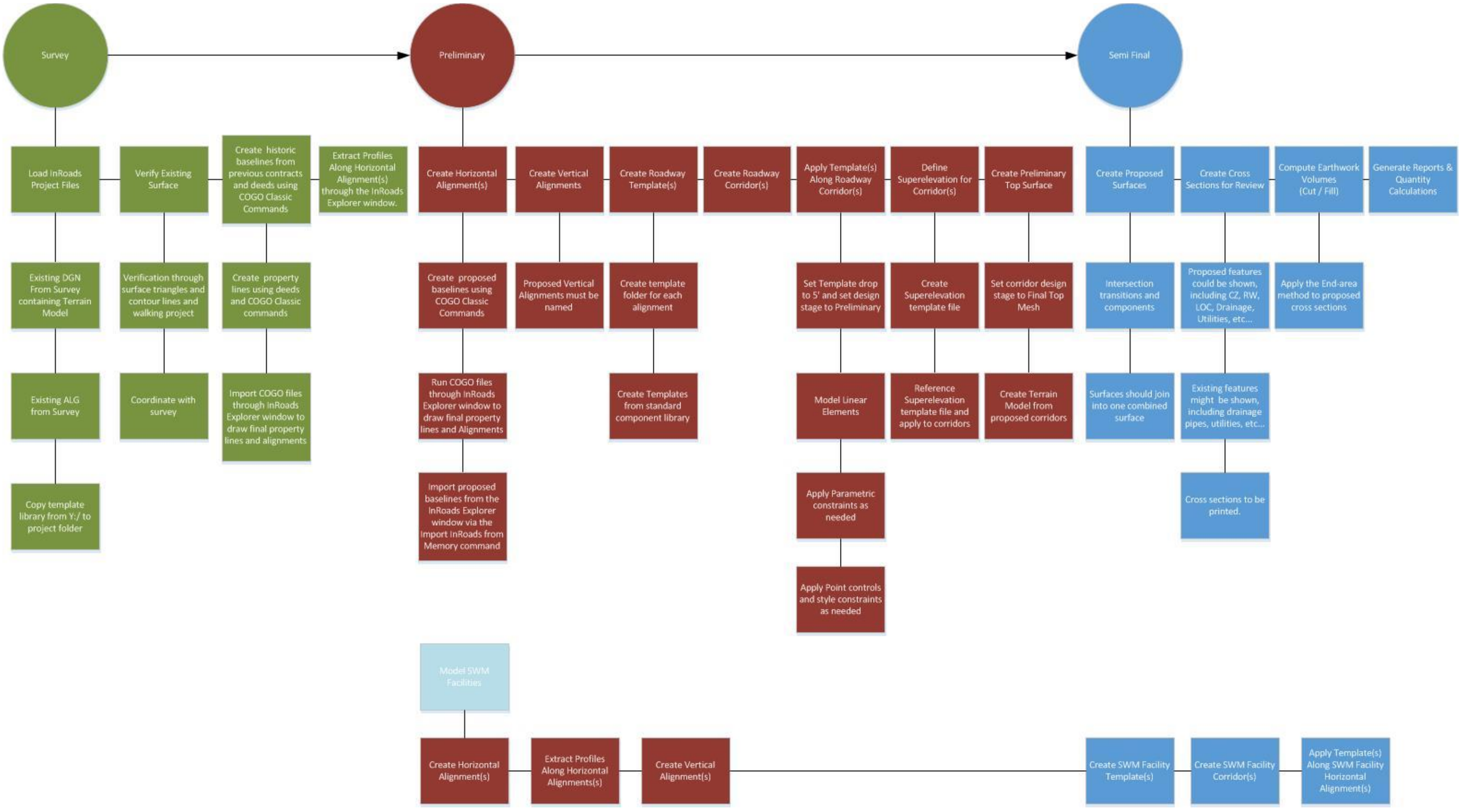
Deliverable Files

Currently the Department is creating the same electronic deliverables for projects that are designed and modeled in SS4 that are created for SS2 projects. Consideration should be given to which electronic files will be provided to the contractor during the scoping phase in order to determine the existing topographic information required.

Workflow

Figure 3 has been created and included to document the designer's workflow when utilizing InRoads SS4 when generating a 3D engineered model

Figure 3: Designer's Workflow in SS4



Engineered Model Density Requirements

The density of the data generated in an engineered model is controlled by the frequency or spacing of the model's template drops. In general, templates should be spaced at a closer interval at complex locations where grades and geometrics are changing or transitioning.

Figure 4 has been created to show the Department's preference in template spacing to be utilized in 3D engineered model generation for an engineered model developed in SS2.

Engineered models that are generated using SS4 should use the template drops that are established by DelDOT CADD standards.

Figure 4 applies to the electronic files that are to be provided to the contractor. During the planning phase and during the design phase, the spacing of the template drops do not have to conform to the requirements of Figure 4 and should be done at the judgement of the designer.

Figure 4: Engineered Model Density Requirements

Location of Template Drop	*Roadway alignment and Profile State*	*Maximum Frequency Spacing (ft)*
Outside of Intersection	Tangent	25
	Horizontal or Vertical Curve	12.5
Inside of Intersection	All	2.5
Interchange Gore Areas	All	2.5

For purposes of Figure 4, the intersection is defined as the area within the intersection extending outward along all roadways to beginning of taper points of the intersection or associated auxiliary lane widening.

Templates should also be dropped at the following key locations:

- Key horizontal geometry points (PC and PT),
- Superelevation transition points,
- Vertical geometry points (VPC and VPT),
- Profile high and low points,
- At the intersection of all side road alignments, and
- Typical section change locations.

In complex existing locations, the model density should be increased to account for the variability in the existing environment and to ensure that the designer's intent is accurately captured in the 3D engineered model.

Engineered Model Detail Requirements

Figure 5 was created as a general reference for which roadway features should be included in the final 3D engineered model to be provided to the contractor. Determining the required detail of a model requires an understanding of how the 3D engineered model will ultimately be utilized. In general, as the engineer is preparing the 3D engineered model they should consider the following questions:

1. Does the model in conjunction with the rest of the Contract Documents provide adequate information to provide the engineer's design intent?
2. If the project has the possibility to use AMG, does the model provide enough information for the contractor to be able to properly utilize AMG technology?

If the answer to either of these questions is no, then more information should be provided in the 3D engineered model.

Designers can also create additional 3D engineered model information to assist in the design process that does not need to be included in the project files that are made available to the contractor.

Figure 5: Engineered Model Detail Requirements

Feature	*Surface Model Required*
Proposed pavement box with edges and pavement breaks	Yes
Side slopes with all slope breaks	Yes
Slope Rounding	No
Proposed curb and base	Yes
Guardrail grading	Yes
Guardrail	Optional
Sidewalk and/ or multi-use paths	Yes
Pedestrian connections	Optional
Underdrain	Yes
Grading around proposed drainage pipes	Optional
Gore areas	Optional
Proposed utilities	Optional
Urban driveway	Yes
Rural driveway	Yes
Minor grading around urban driveway	Optional
Intersection islands	Optional
Construction phases	No
Grading associated with proposed retaining walls	Yes